DRIVERS OF WATER USE AND CONSERVATION ADOPTION BY RESIDENTIAL USERS IN OKLAHOMA: MOTIVATIONS, ATTITUDES, AND PERCEPTIONS

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Chapter I

INTRODUCTION AND BACKGROUND

Introduction

It is important for a community to have a reliable supply of water flowing through their system. Otherwise, many essential daily tasks and functions cannot be performed by households, agriculture and industry. Water use has been growing at more than the rate twice of population increase in the last century (United Nations 2011). The increasing population rate and continued diminishing fresh water supply are currently and will continue to place strain on the water system. The ability of a community to maintain consistent levels of water running through its system may be at risk (Inman and Jeffrey 2006; Wang 2009). It is crucial that leaders in charge of managing and developing water policy for a system assess all options available. To ensure adequate accessibility of water, a community will need to think about increasing their supply of potable water or reducing the demand for water in their community through conservation programs and policies (Renwick and Archibald 1998; Campbell et al. 2004). To guarantee effectiveness, water conservation policies should account for the drivers influencing adoption of new behaviors and technologies. The attitudes, perceptions, and motivations of residential water users are likely to determine the adoption of water conservation alternatives.

Background

Increasing the supply of potable water can be expensive because it requires building new treatment facilities and accessing more expensive sources of water (i.e. desalination of salt water). Generally, investment in infrastructure expansion is assumed to be the most practical option. However, many studies (Renwick and Archibald 1998; Campbell et al. 2004) are beginning to show that reducing the demand for water through conservation programs can be a practical avenue for managing the increasingly scarce resource of water. This is the reason more attention is being focused on how communities can effectively implement water conservation programs to reduce the demand for water in their area (Inman and Jeffrey 2006; Wang et al. 1999; Wang et al. 2005). It has been suggested that more knowledge is needed about the attributes of water users that influence water use and conservation behaviors (Renwick and Green 2000). This will facilitate identification of the most effective demand-side management programs. Establishing the influence of specific attitudes, motivations and perceptions on water use and conservation choices of a household provides a framework for predicting responsiveness to prospective conservation programs.

There are two popular paths to reduce the demand for water, price and non-price demand management strategies. The price charged for water used can be a useful instrument in demand-side water conservation practices (Campbell et al. 2004; Hewitt and Hanemann 1995; Olmstead and Stavins 2009; Wang et al. 2005). Typically, water prices in North America are set below the long-run marginal cost (Timmins 2003). It has been suggested that setting price below the LRMC is inefficient (Olmstead and Stavins, 2009) and that an increasing block rate structure and seasonal pricing (e.g. increase water

prices during summer months) would do a better job at capturing the true economic value of water. Using increasing block rate pricing has shown to be effective as a conservation tool (Campbell et al. 2004; Olmstead and Stavins 2009), but there remain concerns about using price as a conservation instrument. The problem with using pricing as a conservation strategy is that this places more of the conservation burden on low-income households (Renwick and Archibald 1998) as well as can be politically difficult to implement. To use price as a conservation tool is essentially driving a segment of consumers out of the market for water and it is important to consider whether this is just. The United Nations Committee on Economic, Cultural and Social Rights stated "*Water is fundamental for life and health. The human right to water is indispensable for leading a healthy life in human dignity. It is a pre-requisite to the realization of all other human rights.*" In consideration of this, using price as a conservation mechanism may not be the preeminent approach. This increases the need for discovering how successful non-price demand conservation practices can be in reducing the amount of general household water use, without decreasing access to potable water by low-income families.

Non-price water conservation mechanisms are increasingly being examined in the literature (Inman and Jeffrey 2006; Renwick and Archibald 1998; Renwick and Green 2000). The main non-price tools that have been studied are: educational campaigns, rebates (i.e. providing households with financial rebates on low-flow and low-volume water consuming appliances), retrofit kits (i.e. providing households with low-flow showerheads, faucets, etc.), mandatory and voluntary water use restrictions and water allocation policies.

Non-price conservation policies have been shown to significantly reduce the residential demand for water (Michelsen et al. 1999). Timmins (2003) found that for non-price programs to be effective, prices should continue to be set at a rate that is the same as if no conservation mechanism had been adopted. This means, to be effective, average prices charged to consumers should not be dropped in expectation of lower total demand. One problem with a non-price conservation strategy is the possibility of off-setting behavior by the individual (Campbell et al. 2004). An example of this would be when a household installs a low-flow showerhead, and as a result of knowing the new showerhead uses less water, choosing to take longer showers. The initial conservation effect of the showerhead is being offset by the increased time by the individual in the shower.

Research has examined the effect of common household characteristics on the demand for water (Campbell et al. 2004; Inman and Jeffrey 2006; Renwick and Archibald 1998; Renwick and Green 2000). Some common household attributes that have been studied are income, density of neighborhood, household occupancy, number of people per household, home ownership status, and home lot size. Nieswiadomy and Cobb (1993) found that utility managers may be more likely to select conservation rate pricing structures if the individuals in their region are more interested in conservation. Howarth and Butler (2004) discuss the need for people to move through a progressive ideological process of change: from ignorance to awareness to interest to desire and to action. They mention that the public generally regards water as a low priority compared to other environmental issues. It would be useful to policy makers to know where in the process of changing their attitudes and behavior about conservation practices their general

population is. Information on their community's process of change allows policy makers to adjust their policies to accommodate the attitude towards change that water users are in. It is important to understand what factors are influencing the household's decision to move towards practicing conservation behavior. New studies are encouraged for areas that have not been examined because it is difficult to adopt water conservation policies based on previous studies from regions that have different characteristics (Espey et al. 1997). A shortfall of current research is that usually the household attributes studied are general demographic characteristics, as opposed to more complex attributes like a household's motivations, attitude and perceptions that provide insight about the reasons behind a household's water use and conservation behaviors.

Research Problem and Objectives

The economic problem at hand is the potential wasteful use of resources (e.g. money, time, etc.) by a community during implementation of a water conservation policy, without household-level data on water use behaviors and attitudes. The main benefit of a non-price conservation approach is the potential cost-effectiveness of the policy, compared to the high cost of increasing the supply of potable water. However, a conservation policy targeting a reduction in the demand for water will not be cost-effective if it does not produce the behavior change it intends. Research is needed about the household attitudes, perceptions, and motivations that drive water use behavior and adoption of new conservation practices by residential users. It is essential for barriers preventing adoption of new conservation alternatives be determined. Those in charge of creating a conservation policy or managing and the valuable resource water need to have

knowledge of the household water use and conservation choices of individuals in their region to ensure success. By providing enhanced knowledge of household behaviors and attributes, this study enables the effectiveness of conservation programs and water management policies to be enhanced. Knowing the specific barriers preventing adoption of new conservation alternatives in a community will allow them to be targeted. The objective of this study is to calculate the effect of attitudes, motivations and perceptions as a driver of household water use behaviors and adoption of new conservation alternatives. In addition, the study will determine the primary barriers to adoption of a new water conservation behavior or technology.

Chapter II

CONCEPTUAL MODEL

Receptivity Model

One model that may be helpful for determining if a household will adopt a water conservation mechanism is the *Receptivity* model (Jeffrey and Seaton 2004). The receptivity model has been used by studies carried out in Australia (Brown and Davies 2007; Clarke and Brown 2006) as a way to determine the receptivity of households to implementing water conservation mechanisms (i.e. rainwater harvesting, graywater reuse, etc.). Positive attitudes and conservation awareness alone are not adequate predictors of households adopting new water conservation behaviors. The receptivity model provides a framework for statistically measuring the impact of attitudes, perceptions, and motivations on the adoption of new conservation alternatives. It is important to identify the barriers preventing a household from taking up a new conservation behavior. The receptivity model provides a method to empirically measure the barriers to adoption.

The four categories of the receptivity model are: awareness (being capable of searching for new knowledge), association (recognition of the potential benefit of this new knowledge by associating it with needs and capabilities), acquisition (the ability to

acquire new technologies and learn new models), and application (actually apply knowledge to achieve the desired benefit). These categories provide a framework for determining how receptive a household will be to new water conservation practices. Measuring the receptivity of a household also reveals the type of barriers preventing individuals from adopting a conservation alternative. Application or adoption of a water conservation alternative is defined as having installed and used a conservation mechanism or applied knowledge of a conservation practice.

A logit model is run to test the degree that receptivity (as measured by adoption of a conservation alternative) is determined by the attitudes, perceptions and motivations of household *i*. Receptivity to a water conservation alternative, is described by the characteristics X_i for each household *i*. To obtain the coefficients used in the likelihood function, the following logit model (1) is run:

(1) $U_i = \alpha + X_i\beta_{awareness} + X_i\beta_{association} + X_i\beta_{acquisition} + X_i\beta_{application}$; $X_i\beta = 0$ for "none"

To determine the likelihood of household *i* adopting a water conservation alternative, the log-likelihood function (2) is calculated:

(2) $$LF = \sum_{i=1}^{N} [Y_i \ln\left(\frac{e^{X_i\beta}}{1+e^{X_i\beta}}\right) + (1 - Y_i)\ln\left(\frac{e^{X_i\beta}}{1+e^{X_i\beta}}\right)]$$

For any one technology:

Y_i = 1 if the household *i* adopts the conservation alternative

= 0 if the household *i* does not the conservation alternative

To compare the effect of different attitudes, perceptions, and motivations on adoption of a water conservation alternatives by household *i*, the marginal effects equation is used. The marginal effect of characteristic X_i is estimated by the equation (3) that maximizes the likelihood function:

(3) $$\frac{\partial P}{\partial x_{ik}} = P(\beta_k - P\beta_k)$$

The different receptivity categories are tested for each attitude and perception X_i, where *i* represents the number of different household attitudes and perceptions. If the p-value for the coefficient β_k estimated is less than or equal to 0.05, then the likelihood of household *i* being receptive to the new water conservation alternative is influenced by the attitude and perception X_i of household *i*.

Chapter III

METHODS AND PROCEDURES

Survey Design and Implementation

This study followed a multistage survey design and implementation method (Dillman et al., 2007) to create, test, validate and implement the online survey to residents in Oklahoma. The multistage design process involved an initial pre-test using the Receptivity model to determine the influence of attitudes and perceptions on adoption of rainwater harvesting practices by Stillwater, OK residents. After additional modifications, it was pre-tested with 31 Oklahoma residents. The survey instrument was further refined until respondents indicated no problems with the survey question format, information needs, etc. After a second pre-test of the survey, the questionnaire of water users was split into two sections. The first section of the survey focused on water use and conservation in the respondent's community. The second section highlighted questions about the individual's own water use and conservation behaviors. A review of the water conservation literature indicated a list of possible factors driving water use and motivations for conservation in the home and yard (table 1).

The Oklahoma Water Use and Conservation survey was implemented online in January of 2011. Respondents for the survey were recruited by the marketing firm *Market*

Tools, Inc., who provided a balanced sampling frame according to the 2000 US Census for Oklahoma. The aim of the 2011 Oklahoma Water Use and Conservation study is to identify the water conservation alternatives that will be most readily adopted by Oklahoma households, as well as determine the motivations, attitudes and perceptions that are significantly affecting conservation and water use decisions. Recruitment emails were sent to n=1157 panel members, who were offered the cash equivalent of $1.00 to participate. There was an initial screen-out question to determine if the respondent has lived in Oklahoma within the last 5 years. If they answered "no" they were not included in the response group. The screen out question left n=841 respondents and the survey was fully completed and submitted by n=801 Oklahoma residents. This response rate is typical for online surveys that provide small incentives (Dillman et al., 2007).

The study employed the Receptivity model (Brown and Davies, 2007; Jeffrey and Seaton, 2004) to determine Oklahoma household views on water conservation tools and identify potential barriers to their use. Receptivity is empirically calculated as a complex measure that includes questions regarding awareness, association, acquisition, and application. Awareness is related to whether the respondent's community is adequately meeting current water needs, whether climate change was expected to have negative impacts on their community, and whether the community is adequately prepared to meet its near-future water needs. Association is comprised of views on effectiveness of specific tools. Acquisition is comprised of views on cost, difficulty of finding, and difficulty of installing and maintaining specific tools. Application or adoption of water conservation tools is defined as having installed and used a conservation mechanism or applied knowledge of a conservation behavior.

Table 1: Drivers of Water Use and Conservation

Attributes of Households	Category
Willingness to adopt conservation	Conservation Intention (dependent variable)
Household Income [a b d]	Demographics
Household Occupancy [a b d]	Household composition
Household Lot Size [a d e]	Dwelling characteristics
Renter Status [d]	Dwelling characteristics
Location [f]	Climate
Number of bedrooms in each household [a]	Dwelling characteristics
Awareness [c]	Awareness/ Cognitive vs. habit behaviors
Access to Technology [b]	Access
Association [c]	Association
Types of water-related technologies in use [a b d]	Past water use behavior / Acquisition
Garden, pool, etc. [i]	Outdoor area interest & use
Institutional Trust [f]	Institutional trust & fairness
Fairness [f]	Institutional trust & fairness
Restrictions are too restrictive	Restrictions attitude
Cost is high [i]	Pricing attitude
Average cost of water [a]	Pricing & use regulations
Consumer perception that water shortages are likely in the near future [a]	Perceived risk of shortages
Conservation orientation perceived by customers [a c]	Conservation attitude, generally
Cultural/Social Norms [b]	Subjective norm
Inter-personal Trust (Perceived control) [f]	Perceived behavioral control
Cost of installation vs. Potential savings [b]	Pricing & use regulations (or factors)
Climate Factors [bc]	Climate & seasonal factors

[a] Wang et al. 2005; [b] Inman and Jeffrey, 2006; [c] Brown and Davies, 2007; [d] Renwick and Archibald, 1998; [e] Renwick and Green, 2000; [f] Jorgensen et al., 2009; [h] Atwood et al., 2007, [i] Campbell et al. 2004

CHAPTER IV

RESULTS

Summary Statistics of Survey

Table 2. Summary Statistics*

Sample size: 801 Oklahoma residents

Response Rate = 69.2%

Home Ownership

Rent: 19.6% (*31.6%*)

Own: 75.3% (*68.4%*)

Other (e.g. live with family): 5.1% (*N/A*)

Education

Some high school: 2.87% (*13.3%*)

High school graduate: 17.6% (*31.5%*)

Some college/vocational training: 43.57% (*23.4%*)

Bachelor's degree: 24.97% (*13.5%*)

Graduate Degree: 10.99% (*6.8%*)

Income

≤ $20,000: 13.23% (*28.80%*)

$20,000-40,000: 29.09% (*28.20%*)

$40,000-60,000: 19.10% (*19.10%*)

$60,000-80,000: 13.73% (*11.20%*)

$80,000-100,000: 7.87% (*6.00%*)

≥ $100,000: 6.37% (*6.60%*)

Prefer not to answer: 10.61% (*N/A)*

*(*compared to U.S. Census Bureau, Oklahoma Census 2000 in parentheses*)

The Oklahoma Water Use and Conservation Survey yielded 801 complete responses from Oklahoma residents, providing a 69.2% response rate for the study (table 2). The majority of the respondents reported owning their own home (75.3%), which is comparable to the U.S. Census Bureau 2000 Oklahoma Census data (68.4%). The survey panel is slightly more educated (Bachelor's Degree=24.97%, Graduate Degree=10.99%) than the general public (13.5% and 6.8%, respectively). The income data is hard to contrast, since respondents were allowed to choose "prefer not to answer". However, none of the summary statistics are a cause for concern and show a generally well-balanced survey panel.

Table 3. Summary of Conservation Alternative Adoption Rates

Conservation Alternatives	Rate of Adoption	No Barriers to Adoption Identified
Repaired a leaky faucet, showerhead, or toilet	55.4%	67.1%
Changed behavior and daily routines for outdoor use	42.1%	56.5%
Changed behavior and daily routines for indoor use	39.8%	42.4%
Installed new low-flow faucets and/or showerheads	31.7%	34.3%
Installed ultra low-flush toilets	22.7%	23.7%
Installed a water-conserving dishwasher and/or washer	17.5%	24.3%
Installed a rain barrel for outdoor water use	4.04%	8.3%
Replaced lawn or other water-consuming plants	3.57%	19.1%
Other	3.21%	N/A
None of the above	15.1%	N/A

Adoption of Conservation Alternatives

In analysis of the results from the Oklahoma Water Use and Conservation Survey, respondents reported engaging in several different water conservation activities (table 3). Repairing leaks is the principal conservation alternative adopted by Oklahoma residents. The rate of adoption (in descending order) of the next most common alternatives adopted are changes in behaviors or daily routines for indoor and outdoor use, installing new indoor water appliances (e.g. low-flow faucets/showerheads, low-flush toilets, water conserving washer, etc.), installing a rain barrel, changing outdoor plants and finally "other" (any conservation alternative not included in the list). About fifteen percent of the Oklahoma residents surveyed reported engaging in no types of conservation practices.

The study showed relative close proximity between the stated adoption of a conservation alternative and no perceived barriers to adoption. These results are instinctive and do not provide any alarming outcomes that would indicate bias or inconsistency in the data. The number of respondents that have adopted no conservation alternatives and the low adoption of new outdoor conservation technologies are consistent with expectations and illustrate there is room for improvement.

Perceived Barriers to Adoption of New Conservation Practices

The researcher asked respondents of the survey to identify primary barriers to their use of water conservation tools for both indoor and outdoor use. The barriers that were available for respondents to choose from were no barrier (e.g. have already adopted conservation practice), not enough savings, cost is too high, difficult to install or adopt, not enough information, or currently no water shortage. Responses differed significantly

between the alternative conservation choices (tables 4 and 5). It is important to note that the format of the survey permitted respondents to choose more than one "primary barrier" if more than one barrier impacted their decision to adopt a conservation alternative.

Table 4. Perceived Barriers to Adoption of Indoor Conservation Practices

Conservation Practice	No Barrier	Not Enough Savings	Cost Is Too High	Difficult to Install/Adopt	Not Enough Information	Currently No Water Shortage
Changes in behavior and daily routines	42.4%	8.7%	3.5%	9.1%	8.1%	28.3%
Installing low-flow faucets and/or showerheads	34.3%	6.8%	21.9%	9.7%	12.1%	15.3%
Installing ultra low-flush toilets	23.7%	8.6%	49.4%	29.9%	13.0%	18.5%
Installing water-conserving appliances	24.3%	3.8%	54.6%	8.0%	12.4%	18.4%
Repairing leaks	67.1%	3.4%	6.2%	8.4%	6.9%	15.5%

Table 5. Perceived Barriers to Adoption of Outdoor Conservation Practices

Conservation Practice	No Barrier	Not Enough Savings	Cost Is Too High	Difficult to Install/Adopt	Not Enough Information	Currently No Water Shortage
Changes in behavior and daily routines (e.g. water lawn less)	56.5%	5.7%	3.7%	5.2%	6.0%	22.9%
Replacing lawn or other water-consuming plants	19.1%	7.8%	31.3%	18.9%	46.1%	38.4%
Installing a rain barrel	8.3%	10.0%	18.5%	15.7%	36.0%	26.4%

A large segment of respondents indicated that there were “no barriers” to them repairing leaks, which is shown in the prevalent adoption of this conservation behavior. Respondents stated that the primary “perceived barrier” for repairing leaks, changing indoor and outdoor behavior routines, and installing low-flow faucets and/or showerheads is that there actually is no barrier. Stating “no barrier” to adoption means there should relatively be the same amount of respondents that identified themselves as having adopted the behavior. The study places the percentage of households that adopted the conservation alternative alongside the percentage of households that recorded no barrier to adoption (table 3). Stating “no barrier” to adoption is higher than the stated rate of adoption for all conservation choices. However, they were still relatively close, except for replacing lawn or other water-consuming plants which showed a large disparity. About twenty percent of respondents said there is no barrier to them adopting the given conservation practice, but less than four percent said they have replaced their lawn or water-consuming plants to help conserve water in their household.

Another popular reason indicated by respondents for choosing not to adopt a water conservation practice is they perceive no shortage of water in their community. This is the second largest perceived barrier for adopting indoor and outdoor changes in behaviors, repairing leaks, replacing the lawn or other water-consuming plants, or installing a rain barrel. These results make sense because an individual that does not perceive their water supply as being at risk are going to be much less likely to adopt a new conservation behavior. This suggests that knowledge regarding water shortages in a community may have a large influence on the adoption of new conservation tools, especially for outdoor water use.

For two of the outdoor conservation practices, installing a rain barrel and replacing lawn or other water-consuming plants, the principal barrier chosen was not having enough information about the conservation alternative. Almost half of the respondents indicated that not having enough information was the primary barrier preventing them from changing their lawn and plants. More than one-third identified this as the main reason for not installing a rain barrel. Changing outdoor plants and installing a rain barrel were also the two least common conservation practices that respondents reported adopting (besides "other"). Providing more information about these alternatives could be a pathway for increasing their adoption and improving overall community participation in water conservation.

Cost being too high appears to be a key driver in preventing the adoption of several of the conservation mechanisms. This is the primary barrier identified for the installation of ultra low-flush toilets and water-conserving appliances. It was also the second largest perceived barrier indicated for installing low-flow faucets and showerheads and third largest for replacing the lawn and plants and installing a rain barrel. Only a small amount of the respondents indicated cost as a primary barrier to changing indoor and outdoor water behaviors or repairing leaks, which is rational. The results illustrate that providing financial incentives for adopting low-flow faucets and appliances, low-flush toilets, and replacing lawn or other water-consuming plants may be a segment that can be targeted for increasing the overall adoption of conservation alternatives.

The difficulty of installing or adopting a conservation practice appears to be a common barrier for installing ultra low-flush toilets. Nearly one-third of the study

participants indicated this was the case for installing new toilets. Replacing lawn and plants or installing a rain barrel are also seen by many as difficult to install. This indicates that technical support for installing both indoor and outdoor devices may provide a substantial improvement in the adoption rates of these conservation tools.

Perceived Barriers to Households Adopting No Conservation Mechanisms

The study also determined the perceived barriers to households that reported adoption of "none of the above" when asked what conservation alternatives their household had adopted. (table 6).

Table 6. Perceived Barriers to Households Adopting No Conservation Alternatives

None of Household Conservation Alternatives Adopted						
Conservation Practice	No Barrier	Not Enough Savings	Cost Is Too High	Difficult to Install/Adopt	Not Enough Information	Currently No Water Shortage
Changes in indoor behavior and daily routines	7%	9%	7%	12%	19%	46%
Installing low-flow faucets and/or showerheads	4%	2%	25%	15%	20%	34%
Installing ultra low-flush toilets	6%	2%	30%	13%	18%	31%
Installing water-conserving appliances	10%	2%	30%	11%	15%	32%
Repairing leaks	24%	2%	13%	11%	15%	36%
Changes in outdoor behavior and daily routines (e.g. water lawn less)	19%	6%	8%	13%	15%	40%
Replacing lawn or other water-consuming plants	9%	4%	19%	7%	21%	39%
Installing a rain barrel	2%	4%	13%	12%	26%	43%

Currently no water shortage was predominately chosen as a barrier to the adoption of new conservation practices amongst this group. This is fairly intuitive, as a household that chooses not to adopt any conservation alternative would likely not perceive any imminent threat. Cost being too high was consistently the second major barrier to the installation of low-flow and water consuming appliances. Not enough information was the second biggest barrier to this group replacing their lawn or installing a rain barrel.

The percentage of this subset of the survey panel that reported no barriers is rather interesting. This means that 24% of the households that adopted "none of the above" claimed there is no barrier to them repairing leaks in their household and 19% of them stated there is no barrier to them changing outdoor behaviors and routines. This could mean that there is no primary barrier to adoption of these conservation alternatives, but instead merely a lack of willingness to want to practice water conservation. Or there may be inconsistency in the responses of this subset of the population, if there really are common barriers to why they chose not to adopt any conservation alternatives.

Preferences on Watering Restrictions and Price Increases

The results of the Oklahoma Water Use and Conservation survey showed perceived barriers to non-price conservation tools that are typically adopted by residential water users (tables 4, 5, and 6). However, water managers and other individuals involved in creating a water policy may consider using price as a conservation mechanism. The three pricing questions that respondents were asked to indicate their support for were mandatory water restrictions, increased water prices just for high-volume users (conservation pricing), and increased water prices for <u>all</u> users (table 7). Pricing is a difficult conservation tool to adopt if the community is unlikely to support increases in

the price paid for potable water. This is why it is important to gauge the preferences of respondents for watering restrictions and price increases. As the price of water increases, concerns about the cost of water conservation tools, their water savings, and a lack of water shortage may possibly be overcome. Other tools may be expected to increase in use due to higher water prices and outdoor water use restrictions.

Table 7. Preferences on Watering Restrictions and Price Increases

Conservation Practice	Definitely would NOT support	Probably would NOT support	Unsure	Probably would support	Definitely would support
Mandatory Water Restrictions	3.3%	5.5%	14.8%	42.4%	34.0%
Increased water prices for high-volume users (Conservation Pricing)	7.0%	10.5%	22.6%	38.4%	21.6%
Increased water prices for all users	23.3%	31.5%	25.6%	13.9%	5.7%

This study found that the majority of respondents would support or definitely support mandatory water restrictions (which are typically enforced through fines for not following the stated water use restriction) and increased water prices just for high-volume users (conservation pricing). A huge portion of the respondents, one-third, said they would definitely support this tool being used in their community. Forty percent would probably support its use in their community. In total, over three-fourths of the respondents would likely support this tool being used in their community, whereas less than ten percent indicated opposition to its use.

Conservation pricing, or rather increasing pricing for high-volume users, is also generally supported by the individuals surveyed. Sixty percent of the respondents indicated some form of support for this conservation tool, with twenty percent saying

they would definitely support its use. About forty percent of individuals questioned stated probably supporting its use. Less than two-fifths of respondents indicated opposition to its use, and nearly one-quarter are unsure about the use of conservation pricing in their community. Interestingly, the data showed strong opposition to the use of higher average water prices for all users. This intuitively makes sense, because most respondents probably do not perceive themselves as high-volume water users so they do not think the increased prices will affect them. Only about one-fourth of individuals in the survey indicated support for higher average water prices. The mass of respondents oppose the use of increased water prices for all water users to help promote conservation.

Increase in Prices Needed to Encourage Adoption of Conservation

In an effort to gauge how sensitive water users are to prices, the survey asked respondents to indicate the smallest increase in water prices that would be needed for them to adopt additional conservation tools (table 8). In a free market, scarcity of a product is usually communicated through rising prices. The findings of the Oklahoma Water Use and Conservation study are consistent with the literature on the price elasticity of demand for water, which shows that a 5% - 10% increase in water prices results in a 1% drop in water use (e.g., Klein et al., 2006; Nieswiadomy, 1992; Renwick and Green, 2000). This study found that over one-third of respondents would seek to adopt water conservation tools if water prices rise by somewhere between 0-10%. Almost two-thirds of individuals taking the survey said they would adopt additional water conservation tools if the price of water rose by 10-20%. The results indicate that water users are rather sensitive to water prices, and that water price increases may be a strong motivator for the adoption of water conservation tools.

Table 8. Smallest Increase in Water Prices Needed for Adoption of Conservation Tools

Increase in water prices	Percent Frequency	Cumulative Percent Frequency
0-10%	35.90%	35.90%
10-20%	29.19%	65.09%
20-30%	20.50%	85.59%
30-40%	5.71%	91.30%
40-50%	3.11%	94.41%
More than 50%	5.59%	100.00%

Efforts to Conserve Water by Others

The use of water conservation tools depends not just on price, cost, water savings, and other barriers previously discussed but is likely to also depend on the conservation efforts of others in the community and pressure to support conservation in the community (i.e., "moral suasion"). Respondents were asked to gauge the efforts of their neighbors and their water utility to conserve water (table 9). The data showed a large percentage of respondents who were unsure. Roughly one-fourth of respondents hold distrustful views about their neighbors' efforts and their utility's efforts to conserve water. Nearly one-third hold optimistic views about their neighbors' efforts and their utility's efforts on water conservation. Only a small group of respondents do not get water from a water utility, and could not answer the utility-related question. These results indicate that individuals are generally uncertain about conservation efforts in their community, but are a little more likely to view their utilities and neighbors as making efforts to support and promote conservation than making no efforts.

Table 9. Views about Conservation Efforts by Others

Views on Conservation Efforts of Others	Definitely No	Probably No	Unsure	Probably Yes	Definitely Yes	Not Applicable
Do your neighbors make an effort to conserve water?	7.7%	18.3%	40.6%	28.7%	4.8%	N/A
Does your local water utility promote water conservation?	8.7%	17.1%	35.0%	25.9%	10.6%	2.8%

Awareness, Association, and Acquisition of Conservation Alternatives

The *Receptivity Model* is empirically measured using a sequence of econometric models that determine if the adoption of a water conservation mechanism is a function of the awareness, association, and acquisition variables. Several models are evaluated using various explanatory variables. In the model, "awareness" is comprised of respondent's perceptions about if there is currently enough water to meet the needs of their community ("currently enough"), attitude on whether their community will need to increase water supply or reduce water use within the next 20 years ("future need"), and perception about climate change reducing the water supply in their area ("climate change"). "Association" is evaluated by the respondent's views on the effectiveness of each water conservation option ("effectiveness"). "Acquisition" is comprised of the smallest price change that would lead to water conservation tool adoption ("price change"), whether the respondent's household would use less water if the cost increased by 20% ("Use Changed 20"), and how much the respondent's households water has changed in the last 5 years ("Use Changed").

Table 10. Receptivity Model Currently Enough Variable

Currently Enough (Question 2)					
	Definitely No	Somewhat No	Neutral/Not Sure	Somewhat Yes	Definitely Yes
All	1%	8%	18%	37%	33%
Indoor	1%	10%	19%	39%	30%
Low-flow	2%	11%	17%	43%	27%
Low-flush	2%	9%	20%	37%	33%
Appliances	1%	10%	10%	41%	37%
Leaks	1%	9%	18%	39%	33%
Outdoor	1%	11%	17%	43%	28%
Plants	0%	23%	23%	33%	20%
Rain Barrels	9%	21%	6%	44%	21%
None	1%	2%	22%	30%	45%

Table 11. Receptivity Model Future Need Variable

Future Need (Question 3)					
	Definitely No	Somewhat No	Neutral/Not Sure	Somewhat Yes	Definitely Yes
All	3%	4%	32%	35%	23%
Indoor	2%	4%	25%	41%	28%
Low-flow	3%	6%	20%	39%	33%
Low-flush	3%	5%	21%	38%	34%
Appliances	4%	5%	29%	29%	33%
Leaks	2%	4%	26%	40%	27%
Outdoor	2%	3%	26%	38%	32%
Plants	0%	0%	17%	53%	30%
Rain Barrels	0%	0%	26%	41%	32%
None	8%	2%	54%	25%	11%

Table 12. Receptivity Model Climate Change Variable

Climate Change (Question 20)					
	Definitely No	Somewhat No	Neutral/Not Sure	Somewhat Yes	Definitely Yes
All	12%	13%	40%	25%	11%
Indoor	9%	13%	33%	33%	12%
Low-flow	10%	11%	34%	31%	13%
Low-flush	12%	12%	31%	33%	13%
Appliances	16%	7%	37%	29%	11%
Leaks	12%	15%	35%	29%	10%
Outdoor	11%	13%	31%	30%	15%
Plants	17%	3%	13%	50%	17%
Rain Barrels	12%	12%	29%	21%	26%
None	13%	9%	58%	13%	8%

Table 13. Receptivity Model Effectiveness Variable

Effectiveness (Question 11 and 12)					
	Definitely No	Somewhat No	Neutral/Not Sure	Somewhat Yes	Definitely Yes
All	N/A	N/A	N/A	N/A	N/A
Indoor	1%	2%	5%	58%	35%
Low-flow	1%	2%	6%	54%	36%
Low-flush	2%	4%	5%	51%	38%
Appliances	1%	1%	3%	52%	43%
Leaks	1%	1%	3%	33%	62%
Outdoor	1%	2%	3%	44%	50%
Plants	0%	6%	10%	48%	32%
Rain Barrels	0%	3%	6%	44%	47%
None	N/A	N/A	N/A	N/A	N/A

Table 14. Receptivity Model Price Change Variable

Price Change (Question 17)						
	0-10 %	10-20%	20-30%	30-40%	40-50%	More than 50%
All	36%	29%	20%	6%	3%	6%
Indoor	38%	31%	20%	7%	2%	3%
Low-flow	36%	28%	23%	6%	2%	5%
Low-flush	37%	27%	25%	4%	5%	3%
Appliances	40%	25%	22%	3%	5%	5%
Leaks	36%	31%	20%	5%	3%	5%
Outdoor	38%	29%	22%	5%	3%	3%
Plants	30%	23%	40%	0%	7%	0%
Rain Barrels	56%	29%	6%	6%	3%	0%
None	41%	24%	15%	7%	3%	9%

Table 15. Receptivity Model Use Changed 20 Variable

Use Changed 20 (Question 18)					
	Definitely No	Somewhat No	Neutral/Not Sure	Somewhat Yes	Definitely Yes
All	3%	15%	23%	43%	16%
Indoor	2%	13%	18%	46%	21%
Low-flow	3%	13%	23%	43%	17%
Low-flush	1%	16%	18%	47%	17%
Appliances	3%	19%	21%	41%	16%
Leaks	3%	17%	21%	45%	15%
Outdoor	3%	14%	19%	47%	18%
Plants	0%	20%	17%	47%	17%
Rain Barrels	6%	6%	18%	53%	18%
None	4%	13%	38%	35%	11%

Table 16. Receptivity Model Use Changed Variable

Use Changed (Question 15)						
	Definitely No	Somewhat No	Neutral/Not Sure	Somewhat Yes	Definitely Yes	Unsure
All	8%	28%	44%	12%	4%	5%
Indoor	13%	41%	30%	10%	3%	2%
Low-flow	12%	36%	33%	13%	4%	1%
Low-flush	15%	37%	30%	14%	3%	2%
Appliances	8%	36%	36%	14%	3%	2%
Leaks	9%	34%	39%	12%	4%	2%
Outdoor	14%	37%	31%	13%	3%	2%
Plants	17%	33%	30%	17%	0%	3%
Rain Barrels	29%	15%	32%	18%	3%	3%
None	0%	7%	61%	6%	6%	20%

Econometric Model

The parameter estimates for the econometric model are determined (table 17) and the marginal effects based of the explanatory variables are calculated (table 18). The logit model provides a coefficient that is not intuitively understood. However, the coefficient calculated in the model can be plugged into the marginal effects equation. The estimate provided by the marginal effects equation is interpreted as the change in probability of an average respondent adopting a water conservation alternative for each unit increase in a specific explanatory variable. Marginal effects are used in discussion of the results of the Oklahoma Water Use and Conservation survey.

The results show that the receptivity model is useful for explaining the likelihood of Oklahoma water users adopting new water conservation tools. Variables comprising awareness are statistically significant for several of the conservation tools, but these vary somewhat depending on the conservation alternative. Indoor behavior changes are negatively influenced by current need, and positively influenced by future need and

climate change. Low-flow faucets and showerhead use is negatively influenced by current need, and positively influenced by future need. Low-flush toilet installation is positively influenced by future need and appliance installation is not statistically significantly influenced by any awareness variables. Repairing leaks is positively influenced by future need. Changes in outdoor water use behaviors is negatively influenced by current need and positively influenced by future need. Replacing the lawn or other water consuming plants is negatively influenced by current need and the adoption of rainwater harvesting is negatively influenced by current need. Adoption of no conservation behaviors is negatively influenced by future need.

Table 17. Receptivity Model Effects

	Current Enough	Future Need	Climate Change	Effectiveness	Price Change	Use Changed 20	Use Changed
Indoor	-0.1919**	0.1930**	0.1209*	0.7968***	-0.0802	0.1325*	-0.2465***
Low-flow	-0.1516*	0.2214**	0.1086	0.6395***	0.0302	-0.0201	-0.0813
Low-flush	0.00433	0.2757**	0.0318	0.6693***	-0.00242	-0.00363	-0.1605**
Appliances	0.0851	0.0887	0.00142	0.8563	-0.00673	-0.1499	-0.000584
Leaks	-0.0138	0.2840***	-0.0623	0.6061***	-0.0597	-0.0855	0.0443
Outdoor	-0.1624*	0.3433***	0.1300*	0.7234***	-0.0885	0.0491	-0.2105**
Plants	-0.3319*	0.3221	0.1564	0.6464**	0.0727	-0.0135	-0.1615
Rain Barrels	-0.3194*	0.2093	0.0878	1.0637***	-0.3142*	0.0303	-0.0596
None	0.1266	-0.5006**	-0.0393	N/A	0.0249	-0.2044	-0.0618**

*** = 1% Significance, ** = 5% Significance, * = 10% Significance

Table 18. Receptivity Model Marginal Effects

	Current Enough	Future Need	Climate Change	Effectiveness	Price Change	Use Changed 20	Use Changed
Indoor	-0.0451**	0.0454**	0.0284*	0.1875***	-0.0189	0.0312*	-0.0580***
Low-flow	-0.0323*	0.0472**	0.0232	0.1364***	0.0064	-0.0043	-0.0173
Low-flush	0.0007	0.0448**	0.0052	0.1087***	-0.0004	-0.0006	-0.0261**
Appliances	0.0115	0.0120	0.0002	0.1154	-0.0009	-0.0202	-0.0001
Leaks	-0.0034	0.0690***	-0.0151	0.1472***	-0.0145	-0.0208	0.0108
Outdoor	-0.0393*	0.0831***	0.0315*	0.1752***	-0.0214	0.0119	-0.0510**
Plants	-0.0083*	0.0080	0.0039	0.0161**	0.0018	-0.0003	-0.0040
Rain Barrels	-0.0066*	0.0043	0.0018	0.0219***	-0.0065*	0.0006	-0.0012
None	0.0154	-0.0608**	-0.0048	N/A	0.0030	-0.0248	-0.0075**

*** = 1% Significance, ** = 5% Significance, * = 10% Significance

Table 19. Receptivity Model of Fit Statistics

	Likelihood Ratio	Score	Wald	Percent Concordant	Percent Discordant	Somers' D	AIC
Indoor	117.2700 <0.0001*	104.9578 <0.0001*	91.5334 <0.0001*	72.5	27.2	0.453	991.950
Low-flow	65.5391 <0.0001*	59.8259 <0.0001*	55.3786 <0.0001*	67.6	31.9	0.357	973.390
Low-flush	64.2370 <0.0001*	58.3954 <0.0001*	54.0752 <0.0001*	68.5	31.0	0.375	833.897
Appliances	49.8787 <0.0001*	45.0990 <0.0001*	42.8452 <0.0001*	68.1	30.7	0.374	731.396
Leaks	59.9812 <0.0001*	58.2732 <0.0001*	53.1288 <0.0001*	65.7	33.9	0.318	1051.866
Outdoor	105.5642 <0.0001*	97.3267 <0.0001*	87.1929 <0.0001*	70.9	28.7	0.422	1014.686
Plants	20.8692 0.0040*	20.7203 0.0042*	20.0244 0.0055*	73.6	24.5	0.491	251.377
Rain Barrels	44.6457 <0.0001*	42.3146 <0.0001*	36.8669 <0.0001*	80.4	18.7	0.617	253.082
None	38.0797 <0.0001*	39.2653 <0.0001*	36.3341 <0.0001*	67.0	32.3	0.347	677.789

**Willingness to accept a type I error is • =0.05*

As expected, a perceived ability of a community to provide enough water to meet current needs negatively influences adoption of conservation tools. A belief that the community will need to increase their water supply positively influences adoption of a number of conservation tools. Climate change, a perception by the respondent that climate change will reduce the water supply in their area, positively influences adoption of conservation alternatives. However, these variables were not all statistically significant and their relative influence varied by conservation tool.

Attitude about current water needs is measured on a 5-point Likert-like scale, where 1 indicated that the respondent answered “Definitely No” and 5 indicated that the respondent answered “Definitely Yes” to the question “In your opinion, is there currently enough water in your area to meet the needs of your community?” The study reveals that for an increase in the respondent believing there is currently enough water to meet the needs of their community, the probability of them adopting indoor behavior changes falls by 4.5% and adopting changes in outdoor water use behavior decreases by 3.9%. An increase in their level of agreement of currently enough available water causes installation of low-flush toilets to fall by 3.2%, installation of new lawn and plants to be reduced by 0.8%, and installation of rain barrels to fall by 0.6%. This variable is not statistically significant for other conservation tools.

A similar question related to future water needs is asked, where a 1 indicates “Definitely No” and 5 indicates “Definitely Yes” to the question of “In your opinion, will your community need to increase its water supply or reduce water use within the next 20 years?” An increase in the perception that their community will need to increase their supply or reduce water use within the next 20 years increases the probability of the

respondent adopting indoor behavior changes by 4.5% and causes installation of low-flush toilets to rise by 4.7%. Also, installing low-flush toilets increases by 4.5%, fixing leaks increases by 6.9%, adopting outdoor water use behavior changes increases by 8.3%, and the likelihood of adopting no water conservation tools is reduced by 6.1%.

Views on climate change also have the expected impact, but were not highly significant. Only indoor behavior changes and outdoor behavior changes have statistically significant influences from climate change views. For an increase in the belief that climate change will reduce water supply in their community, there is a 2.8% increase in the use of indoor water conservation behaviors and a 3.2% increase in the use of outdoor water conservation behaviors. This shows that educating an individual about climate change may be helpful for increasing changes in water use behaviors.

Association, as captured by views on effectiveness of water conservation tools, was highly influential. For every increase in the perception of a conservation tool as effective in reducing water use, there was an 18.8% increase in the use of indoor water behavior changes, a 13.6% increase in the installation of low-flow faucets/showerheads, a 10.9% increase in the installation of low-flush toilets, a 14.7% increase in repairing leaks, a 17.5% increase in the use of outdoor conservation behavior, a 1.6% increase in the use of water conserving lawn/plants, and a 2.2% increase in the use of rain barrels. Again, indoor and outdoor behavior changes are most heavily influenced by the association component of the receptivity model.

Acquisition is measured by the minimum water price change (as a percentage) that is needed for an individual to choose adopting new water conservation alternatives. It is also calculated by the likelihood of a respondent reducing household water use after a

20% increase in water prices and whether the respondent's household water use has changed within the last five years. All of these explanatory variables provided fairly weak results. As anticipated, the less sensitive a respondent is to a price change makes them less likely to adopt conservation alternatives. For every 10% increase in minimum price change needed to induce conservation, the probability of adopting rain barrels decreases by 0.7%. An increase in the chance that a respondent's household will use less water if prices rise by 20%, results in a 3.1% increase in the adoption of indoor water conservation behaviors. A change in water use over the past five years has a clear influence on the likelihood of adopting water conservation tools.

Table 20. Impact of Attitudes on Adoption of Conservation Tools

	Current Need	Future Need	Effectiveness
Indoor	-0.2138***	0.1763**	0.8545***
Low-flow	-0.1674**	0.2283***	0.6395***
Low-flush	-0.00336	0.2700***	0.6733***
Appliances	0.0778	0.0847	0.8349***
Leaks	-0.0101	0.2724***	0.6028***
Outdoor	-0.1907**	0.3268***	0.7404***
Plants	-0.3599**	0.3368	0.6667***
Rain Barrels	-0.3514**	0.1710	1.1538***
None	0.1258	-0.4834***	-

*** = 1% Significance, ** = 5% Significance, * = 10% Significance

Respondents were asked to respond to the question "Over the last five years, how has your household's water use changed?" where 1 represents a large decrease and 5 a large increase. The data showed that for every unit increase in water use there is a 5.8% decrease in the adoption of indoor water conservation behaviors, a 2.6% decrease in the installation of low-flush toilets, a 5.1% drop in the adoption of outdoor conservation behaviors, and a 0.8% drop in the installation of rain barrels. For comparison, we also tested a conceptual model with only awareness and association variables (table 20). The data still shows that association (effectiveness) is the principal explanatory variable in the model results.

Barriers to Conservation Adoption

Other conceptual models tested included determining perceived barriers and the use of conservation tools (tables 21 and 22). Another calculated the influence of views on community and neighbor efforts on adoption of conservation tools (table 24). Stated barriers to adoption are good indicators of self-reported water conservation tool adoption. For every increase in the perception that water conservation tools do not provide enough water savings, there is a 17.3% drop in the use of indoor behaviors and an 11.6% decrease in the use of low-flow faucets/showerheads. This also results in a 9.8% reduction in the installation of low-flush toilets, a 5.1% decline in the installation of water conserving appliances, and a 3.0% drop in leak repairs. An increase in the view that cost is too high determines a 14.6% drop in the use of low-flow faucets/showerheads, a 15.7% drop in low-flush toilet use, a 6.8% reduction in the installation of water conserving appliances, a 1.6% decline in outdoor water behavior changes, a 2.0% fall in the

installation of water conserving lawn/plants, and a very negligible 0.006% fall in the use of rain barrels.

The perceived difficulty of installation is also a factor in the adoption of a conservation mechanism. An increased perception of difficulty installing the mechanism negatively influences adoption. 9.7% for indoor behaviors, 17.2% for low-flow faucet/showerheads, 8.6% for low-flush toilets, 16.1% for leak repairs, and 14.2% for outdoor behavior changes. Insufficient information was also a major barrier that influences water conservation tool adoption, and negatively influences indoor water behavior changes by 14.9%, low-flow faucets/showerheads by 14.9%, low-flush toilets by 12.5%, water conserving appliances by 3.0%, outdoor behavior changes by 14.5%, and water conserving lawn/plants by 1.8%.

Views about water conservation efforts by neighbors and utilities had little influence with a few important exceptions (Table 24). For every increase in the belief that neighbors are making efforts to conserve water there is an expected 13.8% increase in the use of indoor water conservation behaviors and 20.1% increase in the installation of water conserving appliances. With an increase in the perceive effort of utilities to conserve leak repair increases by 12.8%. There is also a reduction in the likelihood of adopting none of the water conservation tools by 14.2% with an increased perceived effort by utilities.

Table 21. Logit Model Comparing Barriers to Water Conservation Adoption

	Not Enough Water Savings	Cost is too High	Difficult to Install or Adopt	Not Enough Information	Currently No Water Shortage
Indoor	-1.1035***	-0.5225	-0.5408*	-0.9093***	-1.0333***
Low-flow	-0.8876**	-1.1020***	-1.5724***	-1.2139***	-1.3916***
Low-flush	-1.1973**	-1.7275***	-0.9504***	-1.7081***	-0.7479***
Appliances	-1.7002*	-1.4896***	-14.7530	-0.6633*	-1.0070***
Leaks	-1.8043*	-0.4888	-0.7383**	-0.3881	-0.4630**
Outdoor	-0.4000	-0.9680*	-0.8054**	-0.8249**	-0.5767***
Plants	-0.8230	-1.4436*	-1.2548	-1.2418*	-1.3997*
Rain Barrels	-1.5773	-1.3895*	-13.8307	-13.8307	-0.8869*

*** = 1% Significance, ** = 5% Significance, * = 10% Significance

Table 22. Marginal Effects for Logit Model Comparing Barriers to Water Conservation Adoption

	Not Enough Water Savings	Cost is too High	Difficult to Install or Adopt	Not Enough Information	Currently No Water Shortage
Indoor	-0.1725***	-0.0932	-0.0971*	-0.1489***	-0.1778***
Low-flow	-0.1158**	-0.1461***	-0.1722***	-0.1485***	-0.1661***
Low-flush	-0.0984**	-0.1572***	-0.0863***	-0.1247***	-0.0732***
Appliances	-0.0509*	-0.0678***	-0.1200	-0.0300*	-0.0417***
Leaks	-0.3037*	-0.1105	-0.1607**	-0.0891	-0.1058**
Outdoor	-0.0778	-0.1631*	-0.1422**	-0.1452**	-0.1113***
Plants	-0.0123	-0.0203*	-0.0164	-0.0177*	-0.0197*
Rain Barrels	-0.0006	-0.0006*	-0.0018	-0.0159	-0.0004*

*** = 1% Significance, ** = 5% Significance, * = 10% Significance

Table 23. Fit Statistics for Logit Model Comparing Barriers to Water Conservation Adoption

	Likelihood Ratio	Score	Wald	Percent Concordant	Percent Discordant	Somers' D	AIC
Indoor	45.9905 <0.0001*	43.6417 <0.0001*	41.8406 <0.0001*	39.0	17.4	0.216	1357.754
Low-flow	69.4389 <0.0001*	65.5416 <0.0001*	60.6549 <0.0001*	45.1	15.8	0.293	1192.068
Low-flush	71.6645 <0.0001*	66.7152 <0.0001*	58.3476 <0.0001*	50.2	15.6	0.346	976.651
Appliances	62.1890 <0.0001*	53.5504 <0.0001*	38.1336 <0.0001*	48.8	14.2	0.346	830.584
Leaks	16.7359 0.0050*	15.7742 0.0075*	14.8834 0.0109*	23.9	14.2	0.097	1554.140
Outdoor	21.0469 0.008*	19.9717 0.0013*	19.4460 0.0016*	29.6	16.2	0.133	1415.260
Plants	11.3816 0.0443*	11.1468 0.0485*	9.7207 0.0835	46.9	15.2	0.317	278.924
Rain Barrels	34.8365 <0.0001*	27.8924 <0.0001*	7.7853 0.1685	60.1	10.0	0.501	283.946

**Willingness to accept a type I error is* $\bullet$ *=0.05*

Table 24. Influence of Other-Regarding Behavior on Water Conservation Adoption

	Neighbor Conserve	Utility Conserve
Indoor	0.1384*	0.0408
Low-flow	0.0558	0.00484
Low-flush	-0.00291	-0.0654
Appliances	0.2018**	0.0112
Leaks	-0.0754	0.1276**
Outdoor	-0.0330	0.0657
Plants	-0.1176	0.0947
Rain Barrels	0.0508	-0.2029
None	-0.0252	-0.1420*

*** = 1% Significance, ** = 5% Significance, * = 10% Significance

CHAPTER V

SUMMARY AND CONCLUSIONS

The objective of the study was to identify the drivers of water use behaviors and determine the affect of attitudes, perceptions and motivations on the adoption of new conservation alternatives. The study also sought to establish the barriers preventing households from adopting new water conservation technologies and practices. The results of the Oklahoma Water Use and Conservation survey showed that a household's attitude and perception on conservation practices does significantly determine water use choices and adoption of conservation alternatives. There appears to be no common primary barrier to adopting new conservation alternatives, but rather a differentiation of barriers between each conservation mechanism. Association (effectiveness) appears to be the most significant driver of conservation adoption for the explanatory receptivity variables.

While the data illustrates there is room for increase in the adoption rates of all the conservation alternatives studied, repairing a leaky faucet, showerhead, or toilet was the most commonly adopted conservation alternative and changing daily behaviors and routines (indoor and outdoor) was the next most frequently implemented. Conversely, replacing the lawn and other water-consuming plants or installing a rain barrel were the

least common conservation practices adopted by respondents. This is reasonable considering repairing leaks or changing daily behaviors do not require investment in more expensive technologies and appliances and cost being too high was reported as one of the most frequent perceived barriers by respondents. Repairing leaks may also be a common choice by respondents because the types of leaks are not differentiated by the survey. If the leaks that have been reported repaired by respondents are minor leaks (e.g. a dripping faucet) as compared to more severe leaks in the plumbing, the amount of water conserved will be significantly reduced.

Installation of water conserving appliances, low-flow faucets and showerheads, and ultra low-flush toilets were all significantly impaired by the perception that cost was too high for the respondent to adopt. Adoption of low-flow faucets and showerheads experiences the greatest boost in adoption (compared to low-flush toilets and water conserving appliances) as a result of a decrease in the stated barriers to adoption. The data shows that replacing lawn and other water consuming plants or installing rain barrels are both critically limited by lack of information.

The stated belief that there is currently no water shortage in their system is a frequent barrier preventing households from changing their behavior and daily routines using water, as well as installing new appliances or fixing leaks. The conviction that there will be an increased future need for water aspect of the awareness variable also significantly increases the likeliness of a household adopting a mechanism.

The models studied can be very useful for water managers, charged with the responsibility of maintaining a consistent supply of potable water. If the community knew a specific tool they sought to implement, like rain barrels, they could determine the

factor that is most important for driving its adoption. In this case, the largest driver of the adoption of rain barrels is a perceived effectiveness of installing rain barrels to conserve water. Another approach the utility could use is a general water conservation approach that doesn't seek a specific conservation tool in stall, but identify which alternative households would be most receptive to adopt. In the case of this study, water managers would benefit from target indoor and outdoor water behaviors and daily routines, as well as repairing leaks. The findings of this research will be useful for water policy educators and decision makers in developing water programs to meet the demands of their population in the future. Specific barriers to conservation can be indentified based on the type of policy that is desired to be implemented.

The results point out that approaches to implementing water conservation tools would do best to adapt programs and policies to accommodate the specific perceptions of water users in their community. However, the study is limited because it only explains cross-sectional differences in people and cannot recommend approaches to improving the explanatory variables. For example, the receptivity model can indicate that increased association will impact adoption, but not how to heighten association in the population. Furthers study on the topic would benefit from studying how to improve the awareness, association, and acquisition of a community so as to provide a framework for improving the total conservation effort in that area. This survey and model could be replicated in other areas to further test the validity of the findings and assist other regions that will need to make tough decisions about how to manage the precious resource of water in the future. Further study and research would benefit from studying experimental responses to conservation policies targeting the specific needs of a community, rather than just stated

responses. Future studies would benefit from using the receptivity model to target a single conservation alternative, as opposed to several conservation alternatives like in the Oklahoma Water Use and Conservation survey. An example of a single conservation alternative that would be useful to study is the adoption of Smart Water Meters.

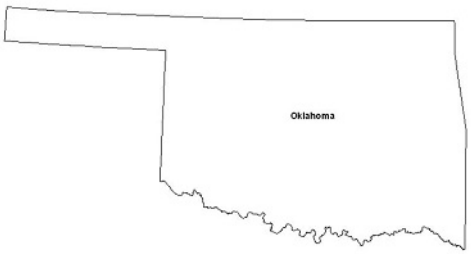
Figure 1. Oklahoma Water Use and Conservation Survey

zoomerang

Oklahoma Water Use and Conservation Survey_V7

Oklahoma Water Use and Conservation Survey

The Oklahoma Water Resources Research Institute and Oklahoma Cooperative Extension Service are concerned with water use and conservation and how they might affect our daily lives and businesses.
Your views and the views of other Oklahoma residents about water use and conservation as provided in the following survey are very important to guide research and educational efforts in our state.
Your response to this survey is important - you are one of only 800 Oklahomans being asked their views on water use and conservation. Your responses will represent the residents of our state.
Would you please complete this questionnaire? It should only take about 7-10 minutes to complete. Also, your response will remain completely confidential, and no personally identifying information is requested.



Page 1 - Question 1 - Yes or No [Mandatory]

Are you an Oklahoma resident, or have you lived in Oklahoma within the last 5 years?

- ❍ Yes [Skip to 2]
- ❍ No [Screen Out]

Page 2 – Heading

Water Use and Conservation in Your Community

Page 2 - Question 2 - Rating Scale - One Answer (Horizontal) [Mandatory]

In your opinion, is there currently enough water in your area to meet the needs of your community?

Definitely No	Somewhat No	Neutral/Not Sure	Somewhat Yes	Definitely Yes
❍	❍	❍	❍	❍

Page 2 - Question 3 - Rating Scale - One Answer (Horizontal) [Mandatory]

In your opinion, will your community need to increase its water supply or reduce water use within the next 20 years?

Definitely No	Somewhat No	Neutral/Not sure	Somewhat Yes	Definitely Yes
❍	❍	❍	❍	❍

Page 2 - Question 4 - Choice - Multiple Answers (Bullets) [Mandatory]

Which of the following water conservation tools or programs has your community used within the last 5 years? (check all that apply)

- ❑ Mandatory watering restrictions
- ❑ Voluntary watering restrictions
- ❑ Helping homeowners install low-flow fixtures and appliances
- ❑ Helping homeowners install rain barrels
- ❑ Paying homeowners to remove turf-grass or plant drought-tolerant plants
- ❑ Increasing water prices for all water users
- ❑ Using conservation pricing so high-volume users pay more for excess water
- ❑ Education and awareness campaigns on water use and conservation
- ❑ None/Don't know

Page 2 - Question 5 - Rating Scale – Matrix [Mandatory]

In your opinion, how effective are the following water conservation tools or programs?

	Very Ineffective	Somewhat Ineffective	Don't Know	Somewhat Effective	Very Effective
Mandatory watering restrictions	❍	❍	❍	❍	❍
Voluntary watering restrictions	❍	❍	❍	❍	❍
Helping homeowners install low-flow fixtures and appliances	❍	❍	❍	❍	❍
Helping homeowners install rain barrels	❍	❍	❍	❍	❍
Paying homeowners to remove turf-grass or plant drought-tolerant plants	❍	❍	❍	❍	❍
Increasing water prices for all water users	❍	❍	❍	❍	❍
Using conservation pricing so high-volume users pay more for excess water	❍	❍	❍	❍	❍
Water budgets/audits for high-volume users	❍	❍	❍	❍	❍
Education and awareness campaigns on water use and conservation	❍	❍	❍	❍	❍

Page 2 - Question 6 - Rating Scale - One Answer (Horizontal) [Mandatory]

In your opinion, do your neighbors make an effort to conserve water?

Definitely No	Somewhat No	Unsure	Somewhat Yes	Definitely Yes
❍	❍	❍	❍	❍

Page 2 - Question 7 - Rating Scale - One Answer (Horizontal) [Mandatory]

In your opinion, does your local water utility promote water conservation?

Definitely No	Somewhat No	Unsure	Somewhat Yes	Definitely Yes	Do not get water from a local water utility
❍	❍	❍	❍	❍	❍

Page 2 - Question 8 - Rating Scale – Matrix [Mandatory]

Please rate your support for the following practices to conserve water during a drought?

	Definitely Would NOT Support	Probably Would NOT Support	Unsure	Probably Would Support	Definitely Would Support
Mandatory water restrictions	❍	❍	❍	❍	❍
Increased water prices for high-volume users (conservation pricing)	❍	❍	❍	❍	❍
Increased water prices for all users	❍	❍	❍	❍	❍

Page 2 - Question 9 - Choice - Multiple Answers (Bullets) [Mandatory]

What information sources have you used to learn about your water prices? (Please check all that apply)

- ❑ Visited the utility's website
- ❑ From a water bill
- ❑ From a utility newsletter
- ❑ Contacted the municipality
- ❑ Visited the municipal website
- ❑ Read an annual report
- ❑ From traditional media (e.g., TV, newspaper, radio)
- ❑ Do not know my water price
- ❑ Do not buy water (e.g., have private well)
- ❑ Other, please specify

.....

Page 3 - Heading

Household Water Use and Conservation

Page 3 - Question 10 - Choice - Multiple Answers (Bullets)
[Mandatory]

Which of the following has your household adopted?

- ❑ Changed behavior and daily routines for indoor use (e.g., shorter showers)
- ❑ Installed new low-flow faucets and/or showerheads
- ❑ Installed ultra low-flush toilets
- ❑ Installed a water-conserving dishwasher and/or washer
- ❑ Repaired a leaky faucet, showerhead, or toilet
- ❑ Changed behavior and daily routines for outdoor use (e.g., watering lawn less often)
- ❑ Replaced lawn or other water-consuming plants
- ❑ Installed a rain barrel for outdoor water use
- ❑ None of the above
- ❑ Other, please specify

Page 3 - Question 11 - Rating Scale – Matrix [Mandatory]

In your opinion, how effective are each of the following for reducing household indoor water use?

	Very Ineffective	Somewhat Ineffective	Unsure	Somewhat Effective	Very Effective
Changes in behavior and daily routines (e.g., taking shorter showers)	❍	❍	❍	❍	❍
Installing low-flow faucets and/or showerheads	❍	❍	❍	❍	❍
Installing ultra low-flush toilets	❍	❍	❍	❍	❍
Installing water-conserving appliances (e.g., dishwasher)	❍	❍	❍	❍	❍
Repairing a leaky faucet, showerhead, or toilet	❍	❍	❍	❍	❍

Page 3 - Question 12 - Rating Scale – Matrix [Mandatory]

In your opinion, how effective are each of the following for reducing household outdoor water use?

	Very Ineffective	Somewhat Ineffective	Unsure	Somewhat Effective	Very Effective
Changes in behavior and daily routines (e.g., watering grass lawn less often)	❍	❍	❍	❍	❍
Replacing lawn or other water-consuming plants	❍	❍	❍	❍	❍
Installing a rain barrel	❍	❍	❍	❍	❍

Page 3 - Question 13 - Rating Scale - Matrix [M

What barriers prevent your household from adopting each of the following for indoor water conservation?

	No Barriers (Have already adopted)	Not Enough Water Savings	Cost is Too High	Difficult to Install or Adopt	Not Enough Information	Currently No Water Shortage
Changes in behavior and daily routines (e.g., taking shorter showers)	❍	❍	❍	❍	❍	❍
Installing low-flow faucets and/or showerheads	❍	❍	❍	❍	❍	❍
Installing ultra low-flush toilets	❍	❍	❍	❍	❍	❍
Installing water-conserving appliances (e.g., dishwasher)	❍	❍	❍	❍	❍	❍
Repairing a leaky faucet, showerhead, or toilet	❍	❍	❍	❍	❍	❍

Page 3 - Question 14 - Rating Scale – Matrix [Mandatory]

What barriers prevent your household from adopting each of the following for outdoor water conservation?

	No Barriers (Have already adopted)	Not Enough Water Savings	Cost is Too High	Difficult to Install or Adopt	Not Enough Information	Currently No Water Shortage
Changes in behavior and daily routines (e.g., watering grass lawn less often)	❍	❍	❍	❍	❍	❍
Replacing lawn or other water-consuming plants	❍	❍	❍	❍	❍	❍
Installing a rain barrel (costing about $50 to $100)	❍	❍	❍	❍	❍	❍

Page 3 - Question 15 - Rating Scale - One Answer (Horizontal) [Mandatory]

Over the last five years, how has your household's water use changed?

Large Decrease	Small Decrease	Stayed About the Same	Small Increase	Large Increase	Unsure
❍	❍	❍	❍	❍	❍

Page 3 - Question 16 - Choice - One Answer (Bullets) [Mandatory]

About how much does your water cost (per 1,000 gallons)? Note: the typical household uses about 5,000 gallons per month.

- ❍ Less than $1.00
- ❍ $1.00 - $2.00
- ❍ $2.00 - $3.00
- ❍ $3.00 - $4.00
- ❍ More than $4.00
- ❍ Do not know

Page 3 - Question 17 - Choice - One Answer (Bullets) [Mandatory]

What is the smallest rise in water prices needed for your household to adopt new conservation tools or behaviors?

- ❍ 0 - 10%
- ❍ 10 - 20%
- ❍ 20 - 30%
- ❍ 30 - 40%
- ❍ 40 - 50%
- ❍ More than 50%

Page 3 - Question 18 - Rating Scale - One Answer (Horizontal) [Mandatory]

Would your household use less water if the cost increased by 20%?

Definitely No	Probably No	Neutral/Unsure	Probably Yes	Definitely Yes
❍	❍	❍	❍	❍

Page 3 - Question 19 - Rating Scale - One Answer (Horizontal) [Mandatory]

Based on this scale, please indicate your attitude about the use of water and other natural resources:

Total natural resource use	More use than protection	Equal Balance	More proection than use	Total environmental protection
❍	❍	❍	❍	❍

Page 3 - Question 20 - Rating Scale - One Answer (Horizontal) [Mandatory]

Do you believe that climate change will reduce water supply in your area?

Definitely No	Somewhat No	Unsure	Somewhat Yes	Definitely Yes
❍	❍	❍	❍	❍

Page 4 - Heading

Tell Us About Yourself

Page 4 - Question 21 - Choice - One Answer (Bullets) [Mandatory]

What is your household's drinking water source?

- ❍ Private Supply (Private well, etc)
- ❍ Public Supply (City water utility)
- ❍ Public Supply (Rural water district)
- ❍ Bottled Water
- ❍ Unsure

Page 4 - Question 22 - Choice - One Answer (Bullets) [Mandatory]

Approximately how large is your community size?

- ❍ Less than 3,500 people
- ❍ 3,500 to 7,000 people
- ❍ 7,000 to 25,000 people
- ❍ 25,000 to 100,000 people
- ❍ More than 100,000 people
- ❍ Unsure

Page 4 - Question 23 - Open Ended - One Line

What is your zip code?

Page 4 - Question 24 - Choice - One Answer (Bullets) [Mandatory]

Do you rent or own your home?

- ○ Rent
- ○ Own
- ○ Other (e.g. live with family)

Page 4 - Question 25 - Choice - Multiple Answers (Bullets) [Mandatory]

Does your home have any of the following? (Check all that apply)

- ☐ Lawn
- ☐ Irrigation system
- ☐ Pool
- ☐ Garden
- ☐ None of the above

Page 4 - Question 26 - Choice - One Answer (Bullets) [Mandatory]

Including yourself, how many people live in your household?

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ More than 5

Page 4 - Question 27 - Choice - One Answer (Bullets) [Mandatory]

How many bathrooms does your home have?

- ○ 1
- ○ 1.5 or 2
- ○ 2.5 or 3
- ○ 3.5 or 4
- ○ More than 4

Page 4 - Question 28 - Open Ended - One Line

What is your age?

Page 4 - Question 29 - Choice - One Answer (Bullets) [Mandatory]

What is your education level?

- ○ Some High School
- ○ High School Graduate
- ○ Some College or Vocational Training
- ○ Bachelors Degree
- ○ Graduate Degree

Page 4 - Question 30 - Choice - One Answer (Drop Down) [Mandatory]

What is your household's annual income?

- ○ Less than $20,000
- ○ $20,000 - $40,000
- ○ $40,000 - $60,000
- ○ $60,000 - $80,000
- ○ $80,000 - $100,000
- ○ More than $100,000
- ○ Prefer not to answer

Page 4 - Question 31 - Choice - One Answer (Bullets)

Approximately how much time did it take you to complete this survey?

- ○ Less than 5 minutes
- ○ 5 - 10 minutes
- ○ 10 - 15 minutes
- ○ More than 15 minutes

Page 4 - Question 32 - Open Ended - Comments Box

Thank you for your time! Please provide any comments about the survey in the space below.

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VITA

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Abstract:

Increased strain is being placed on water systems from population growth and diminishing freshwater supplies. Assessment of all options available to those in charge of managing the supply for these systems is crucial. Many communities have had sufficient water levels to meet demand in the past, but will need to make tough decisions about how to manage the precious resource of water in the future. Determining the influence of a household's motivations, attitudes, and perceptions on their water use and adoption of conservation practices provides a framework for understanding their receptivity to prospective water policies and conservation programs. This study identified the residential water user's motivations, attitudes, and perceptions about water use and conservation alternatives. This research provides timely insight on the preferences of water users in Oklahoma and how they think water should be used and conserved. The receptivity model provides a model for understanding and predicting why a household chooses a water use behavior or conservation alternative. The results from the study show that repairing leaks has been the most common conservation alternative adopted and installing rain barrels the least. Associating a conservation alternative's ability to improve a need appears to be the most significant driver of conservation adoption. The findings of this research will be useful for water policy educators and decision makers in developing water programs to meet the future demands of their population.

ADVISER'S APPROVAL: Dr. Larry Sanders